

Ultrananocrystalline Diamond: A New Allotrope of Carbon

- Ultrananocrystalline diamond (UNCD) is grown using a new plasma deposition (PECVD) process, and consists of ultra-small (2-5 nm) grain sizes and *atomically*-abrupt grain boundaries. UNCD films are smooth, dense, and phase-pure, and can be conformally coated on a wide variety of materials and high-aspect-ratio structures.
- UNCD has been found to have many unique materials properties, several of which are *tunable* via doping of nitrogen into the films:
 - Mechanical (high hardness and fracture strength)
 - Tribological (low friction, thermal conductance)
 - Transport (electronic, thermal)
 - Electrochemical (wide working potential window)
 - Electron Emission (low, stable threshold voltage)
- The ultra-small grain size, conformal coating capability, and differential etch chemistry of UNCD allows the fabrication of all-diamond structures with better than 0.1 μm feature sizes, enabling the development of UNCD micro-instrumentation and UNCD-MEMS.
- UNCD is finding a very wide range of applications:
 - Microelectromechanical Systems (MEMS)
 - Rotating shaft pump seals
 - Photonic Switches
 - Electronic devices (pn junctions)
 - Field emission cathodes
 - Electrochemical electrodes
 - Hermetic Coatings on bioimplants
- The 2000 MRS Award was presented to Dieter Gruen for the development of UNCD by Gruen and co-workers at ANL/MSD over the past ten years.

